no evidence that either electricity or magnetism has anything to do with the arrangement of coronal matter in the Sun's neighborhood. A re-examination of the photographs of other eclipses of which the observatory has copies leads to the same conclusion, viz: there is no necessity of introducing either electrical or magnetic forces to account for any of the coronal forms, as each true stream-line can practically be made to lie on the arc of a conic section having the sun at the focus. The abnormally curved streamers, usually forming wing-boundaries on the smaller scale photographs of the present eclipse are, on the larger negatives, shown to be due to the overlapping of different nearly osculating streamers, the individual members, however, can be made to coincide with the arc of a gravitational conic section. It is almost certain that the abnormal outlines recorded for other eclipses are produced in a similar manner."

LUNAR ECLIPSES AND SOME SIMILAR PHENOMENA.

By W. H. S. Monck.

The two most remarkable characteristics of lunar eclipses are the large amount of light which frequently appears on the eclipsed Moon and the fact that the eclipse—the true shadow—is larger than the geometrical shadow. The connection between these two facts has not perhaps been as fully recognized as it ought to be.

No one can doubt that the light which falls on the eclipsed part of the Moon comes from the Sun, and that it does not pass through the solid body of the Earth. Placing the corona out of account for the present therefore, the only explanation is that light, which would otherwise pass outside of the geometrical shadow, has been turned out of its direct course so as to fall within that shadow. This diversion of the light must naturally produce a deficiency at the place from which it has been diverted. And I think there can be little doubt that the cause which diverts the light is the Earth's atmosphere. Bending the rays which pass near the Earth into the geometrical shadow, it naturally leaves a deficiency of light for some distance outside of that shadow. The result is that the eclipsed Moon is at least partially illuminated, while the real shadow becomes larger than the geometrical shadow.

One consequence of this explanation is that great mountain-ranges like the Andes and Cordilleras, for example, will produce no effect on the terminator of the Earth's shadow on the Moon. The effect would be produced if we had no atmosphere, but the actual terminator does not correspond to the Earth's surface but to the atmosphere at a height of probably 50 or 60 miles, which is of course unaffected by the mountain-range. The mountains, by cutting off the light that would otherwise pass over the Earth nearly at the sea-level, will lessen the illumination of part of the eclipsed Moon, but this effect will take place not at the terminator but some distance inside of it. Whether the diminution would be sufficient to attract notice I cannot say. I can only point out where it should be looked for. Great banks of cloud would have the same effect—a darkening within the terminator. Bright and dark eclipses would, according to this view, depend mainly on the state of the atmosphere at the time. The distance of the Moon from the Earth and the breadth of the shadow at the place where the Moon crosses it would of course also affect the quantity of light bent into the centre of the shadow. There might be occasions when the bending was not sufficient to throw the light into the centre of the shadow if clouds or mountains intercepted the more strongly refracted rays. But the corona introduces a new element. The corona is known to vary from time to time in its dimensions, and I apprehend that the varying dimensions of the corona must affect the phenomena of a lunar eclipse.

Suppose, for simplicity, that the terrestrial atmosphere is removed, what is the condition of the part of the Moon immediately inside of the terminator? The Sun is cut off by the Earth, but the corona is still visible as we see it in a solar eclipse. The degree of illumination and the distance to which it extends inside of the geometrical shadow will depend on the brilliancy and extent of the corona, but the general effect will be that inside of the geometrical shadow there will be a ring of coronal light tracing out the shape and brightness of the corona on the eclipsed Moon. Now it is a remarkable fact that in many lunar eclipses there appears to have been a kind of ring within the terminator consisting of light differently colored from that which was visible nearer to the centre of the shadow. This ring, if examined with sufficient care, would I think have revealed the shape and brightness of the corona at the time of the eclipse. I hope, therefore, that the phenomena of lunar eclipses will be carefully studied in

future. The total phenomenon is a complex one, the effect of atmospheric refraction and coronal light being mixed together within the terminator; but with careful observation we might, perhaps, be able to discriminate the effects of each.

Let me apply the principles here considered to a transit of *Mercury* or *Venus*. If these planets have atmospheres, some of the light will be bent into the geometrical shadow, as in the case of the Moon. But, owing to their great distance from us, this light will, in most instances, not merely be bent into the geometrical shadow but will intersect it on the opposite side and get clear of it altogether. But the deficiency of light in the region from which it was bent into the shadow will remain, and if the planet or other object has an atmosphere, it will be surrounded by a ring less bright than the Sun or other body over whose surface it is passing. Similar results probably arise in the case of eclipse-stars, variables of the type of *Algol*. If the star which effects a transit has an atmosphere, there is a phenomenon similar to the enlargement of a lunar eclipse. It intercepts more light than its real magnitude will account for. Its atmosphere bends a number of the incident rays quite out of the visible direction of the star and they only reach us in the form of diffused sky-light. On the other hand, a star might be visible during a total eclipse if it had a very vivid corona, or, it may be added, if the eclipsing star was not quite dark.

The phenomena of the occultation of a fixed star by the Moon bear some similarity to those which I have been considering. The disappearance is usually instantaneous, proving, in the opinion of most astronomers, that the Moon has no atmosphere. Sometimes, however, the disappearance is slower. This may arise from the Moon's atmosphere not being of a permanent character. If our atmosphere consisted exclusively of aqueous vapor, a lunar astronomer would probably be much puzzled by the phenomena of terrestrial occultations. Sometimes a star seems to be visible after it has entered on the dark body of the Moon, as if its light was bent round the corner. Slow disappearance, however, may arise from the star being a close double or having a very large atmosphere (being possibly the nucleus of a small nebula) or a very brilliant and extensive corona. Considering the very small real discs of the fixed stars the Moon's angular motion is too rapid for making satisfactory observations. The occultation of a fixed star by a planet, when observed with a

powerful telescope, ought to afford more information both as to the planet's atmosphere and the nature of the star. Our own experience, however, shows us that we ought not to assume planetary atmospheres to be always clear. A lunar astronomer would often see a star occulted by the Earth, then reappearing and then occulted again—the first occultation being due to a bank of clouds which it cleared before getting behind the solid body of the Earth. Something like this is said to have occurred with *Jupiter* and may have arisen from this cause. Perhaps the best chance of obtaining information as to the real dimensions of the disc of a star would be an occultation by an asteroid, but such occultations are rare and difficult to predict. A star with a large corona or surrounded by a nebula might not totally disappear at any stage. Every observer has probably noticed that the discs of stars do not appear of the same size in the telescope, and that a fainter star often shows a larger disc than a brighter one. This may arise from the latter star being a close double or being surrounded by a nebula or a large and bright corona. If we could permanently shut out the body of the Sun from view, it would probably be taken as a kind of ring nebula.

In the case of some variable stars, I think there may be an occultation of a different kind. Their periods are very nearly equal to one year. This looks as if the obscuring body, whatever its nature may be, lay between the Earth and the star when we are at one part of our orbit, while at another part the intervening space is clear. The period, of course, might be a little lengthened or shortened by the mutual motions of the star and the obscuring body, the latter of which would probably be a nebula or meteor-swarm of considerable dimensions. This, however, is only conjecture, and I fear it will be difficult to obtain any information as to this class of occultations if they occur. A faint nebula apparently in the same direction as the star is probably the only indication that the most powerful telescope could detect. Such a nebula apparently surrounding a star which varied in a period of about a year would be a suggestive circumstance, but would hardly make out the case conclusively.

With regard to stars whose directions differ considerably from each other, it is still evident that the light of one is most probably, to a considerable extent, reflected or refracted when it falls upon another, giving rise to diffuse sky-light which cannot be traced to any particular star. While, therefore, the greater part of the

diffused light which we observe arises from atmospheric dispersion or from the direct light of stars which are too faint to be separately discernible, it is not wholly traceable to these causes. The light which is visible before a bright star enters the field of the telescope, however, is probably due almost entirely to the terrestrial atmosphere.

PREDICTIONS FOR THE TRANSIT OF MERCURY, NOVEMBER 10, 1894.

By Roger Sprague.

TIMES OF INGRESS AND EGRESS (EXTERNAL CONTACT) FOR UNIVERSITY PARK, COLORADO SPRINGS, PUEBLO, AND TRINIDAD, COL.

UNIVERSITY PK. Lat. 39° 40′ 36″ Long. 104° 56′ 54″ Log. ρ 9.999402		COL. SPRINGS. Lat. 38° 50′ Long. 104° 49.′5 Log. ρ 9.999424		PUEBLO. Lat. 38° 17′ Long. 104° 36′ Log. ρ 9.999438		TRINIDAD. Lat. 37° 11′ Long. 104° 30′ Log. ρ 9.999465	
INGRESS. A. M. M. S. T.	EGRESS. P. M. M. S. T.	INGRESS. A. M. M. S. T.	EGRESS. P. M. M. S. T.	INGRESS. A. M. M. S. T.	EGRESS. P. M. M. S. T.	INGRESS. A. M. M. S. T.	EGRESS. P. M. M. S. T.
H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H M. S.
8 55 59.2	2 12 16.94	8 55 58.91	2 12 16.46	8 55 58.96	2 12 16.07	8 55 59.18	2 12 15.45

University Park, Arapahoe Co., Colorado, Sept. 17, 1894.

PLANETARY PHENOMENA FOR JANUARY, FEBRUARY AND MARCH, 1895.

By Professor Malcolm McNeill.

The following brief notes on the Sun, Moon and planets, have been prepared at the request of the Council, and are designed for the aid of those interested in astronomy and who do not have an almanac. In the descriptive paragraphs Pacific Standard time is given, unless the contrary is indicated.

January, 1895.

The Earth is in perihelion on January 2 at 4 P.M.

Mercury at the beginning of the month is a morning star too